

## CLAIMS

1. A heat exchange system comprising:

an evaporator (3) surrounding a heat radiating portion (7) to evaporate a coolant  
5 in said evaporator;

a condenser (4) condensing said coolant;

a conduit (8) guiding said coolant from said evaporator (3) to said condenser  
(4); and

a return pipe (9) returning from said condenser (4) to said evaporator (3) said  
10 coolant condensed by said condenser (4), wherein in said evaporator (3) a distance  
between an opening (9A) of said return pipe (9) and an inner circumferential surface  
(11A) of said evaporator (3) is smaller than that between an opening (8A) of said  
conduit (8) and said inner circumferential surface (11A).

15 2. The heat exchange system according to claim 1, wherein said conduit (8)  
and said return pipe (9) are connected to said evaporator (3) at an outer circumferential  
surface (11) and said return pipe (9) protrudes toward said inner circumferential surface  
(11A) of said evaporator (3) to be closer to said inner circumferential surface (11A) than  
said conduit (8) does.

20 3. A Stirling refrigerator having said evaporator (3) of the heat exchange  
system of claim 2 attached to a Stirling refrigerating machine (1) at a heat radiating  
portion (7) to allow the system to cool said heat radiating portion (7).

25 4. The heat exchange system according to claim 1, wherein said conduit (8) is  
connected to said evaporator (3) at an outer circumferential surface (11) and said return  
pipe (9) is connected to said evaporator (3) at an axial end surface (12).

5. A Stirling refrigerator having said evaporator (3) of the heat exchange system of claim 4 attached to a Stirling refrigerating machine (1) at a heat radiating portion (7) to allow the system to cool said heat radiating portion (7).

5           6. A heat exchange system comprising:  
a plurality of sub evaporators (3A, 3B) surrounding a heat radiating portion (7) to evaporate a coolant in said evaporators;  
a condenser (4) condensing said coolant;  
a conduit (8) guiding said coolant from each of said sub evaporators (3A, 3B) to  
10 said condenser (4); and  
a return pipe (9) returning from said condenser (4) to each of said sub evaporators (3A, 3B) said coolant condensed by said condenser (4), wherein said return pipe (9) is connected to each of said sub evaporators (3A, 3B) at a position closer to an end surface (15) of said sub evaporator that traverses said sub evaporator's  
15 circumferential direction than said conduit (8) is.

7. The heat exchange system according to claim 6, wherein said conduit (8) and said return pipe (9) are connected to said evaporator (3A, 3B) at an outer circumferential surface (11) and said return pipe (9) protrudes toward said inner circumferential surface (11A) of said evaporator (3A, 3B) to be closer to said inner circumferential surface (11A) than said conduit (8) does.

8. A Stirling refrigerator having said evaporator (3A, 3B) of the heat exchange system of claim 7 attached to a Stirling refrigerating machine (1) at a heat radiating  
25 portion (7) to allow the system to cool said heat radiating portion (7).

9. The heat exchange system according to claim 6, wherein said conduit (8) is connected to said evaporator (3A, 3B) at an outer circumferential surface (11) and said

return pipe (9) is connected to said evaporator (3) at an axial end surface (12).

10. A Stirling refrigerator having said evaporator (3A, 3B) of the heat exchange system of claim 9 attached to a Stirling refrigerating machine (1) at a heat radiating portion (7) to allow the system to cool said heat radiating portion (7).

11. A heat exchange system comprising:  
an evaporator divided into sub evaporators (3A, 3B);  
a condenser (4) condensing said coolant;  
a conduit (8) guiding said coolant from each of said sub evaporators (3A, 3B) to said condenser (4);  
a return pipe (9) returning from said condenser (4) to each of said sub evaporators (3A, 3B) said coolant condensed by said condenser (4); and  
a connection pipe (17) connecting said sub evaporators (3A, 3B) to allow said sub evaporators (3A, 3B) to communicate a liquid coolant.

12. The heat exchange system according to claim 11, wherein said conduit (8) and said return pipe (9) are connected to said evaporator (3A, 3B) at an outer circumferential surface (11) and said return pipe (9) protrudes toward said inner circumferential surface (11A) of said evaporator (3A, 3B) to be closer to said inner circumferential surface (11A) than said conduit (8) does.

13. A Stirling refrigerator having said evaporator (3A, 3B) of the heat exchange system of claim 12 attached to a Stirling refrigerating machine (1) at a heat radiating portion (7) to allow the system to cool said heat radiating portion (7).

14. The heat exchange system according to claim 11, wherein said conduit (8) is connected to said evaporator (3A, 3B) at an outer circumferential surface (11) and

said return pipe (9) is connected to said evaporator (3A, 3B) at an axial end surface (12).

15. A Stirling refrigerator having said evaporator (3A, 3B) of the heat exchange system of claim 14 attached to a Stirling refrigerating machine (1) at a heat radiating portion (7) to allow the system to cool said heat radiating portion (7).

16. A heat exchange system comprising:  
an evaporator (3) surrounding a heat radiating portion (7) to evaporate a coolant in said evaporator;

a condenser (4) condensing said coolant;

a conduit (8) guiding said coolant from said evaporator (3) to said condenser (4);

a return pipe (9) returning from said condenser (4) to said evaporator (3) said coolant condensed by said condenser (4); and

a preventer (16) provided in said evaporator (3) to prevent a liquid coolant from flowing into said conduit (8).

17. A Stirling refrigerator having said evaporator (3) of the heat exchange system of claim 16 attached to a Stirling refrigerating machine (1) at a heat radiating portion (7) to allow the system to cool said heat radiating portion (7).

18. A heat exchange system comprising:

an evaporator (3) surrounding a heat radiating portion (7) to evaporate a coolant in said evaporator;

a condenser (4) condensing said coolant;

first and second conduits (8) guiding said coolant from said evaporator (3) to said condenser (4); and

a return pipe (9) returning from said condenser (4) to said evaporator (3) said

coolant condensed by said condenser (4), wherein said return pipe (9) is connected to said evaporator (3) between locations having said first and second conduits (8A, 8B) connected to said evaporator (3).

5           19. A Stirling refrigerator having said evaporator (3) of the heat exchange system of claim 18 attached to a Stirling refrigerating machine (1) at a heat radiating portion (7) to allow the system to cool said heat radiating portion (7).

          20. A loop thermosyphon comprising:  
10           an evaporator (111) depriving a heat source of heat to evaporate a working fluid in said evaporator; and  
          a condenser (113) externally radiating heat of said working fluid to condense said working fluid in said condenser, said evaporator (111) and said condenser (113) being connected to allow said working fluid to circulate between said evaporator (111)  
15           and said condenser (113), wherein said evaporator (111) at a portion abutting against said heat source is roughened on an internal wall surface (115b) thereof.

          21. The loop thermosyphon according to claim 20, wherein said evaporator (111) includes a plurality of sub frames (115, 116, 117, 118) connected together with a  
20           brazing material (121) to assemble said evaporator (111).

          22. A Stirling refrigerator having a Stirling refrigerating machine (101) mounted therein, wherein:  
          said Stirling refrigerating machine (101) includes the loop thermosyphon recited  
25           in claim 20; and  
          said evaporator (111) is adapted to exchange heat with a heat radiation portion (104) of said Stirling refrigerating machine (101).

23. A heat radiation system comprising a heat radiating portion (104), an evaporator (111) depriving said heat radiating portion (7) of heat to evaporate a working fluid in said evaporator, and a condenser (113) externally radiating heat of said working fluid to condense said working fluid in said condenser, said evaporator (111) and said condenser (113) being connected to allow said working fluid to circulate between said evaporator (111) and said condenser (113), wherein:

said evaporator (111) is formed of an annular frame (119) having a path therein for passing said working fluid;

said annular frame (119) has an opening closer to said heat radiating portion (104), as seen in a cross section including an axial line of said annular frame (119);

said path is defined by an internal wall surface of said annular frame (119) and an external wall surface (104b) of said heat radiating portion (104) positioned to close said opening; and

said heat radiating portion (104) on said external wall surface (104b) at a portion facing said path is roughened.

24. A Stirling refrigerator having a Stirling refrigerating machine (101) mounted therein, wherein:

said Stirling refrigerating machine (101) includes the heat radiation system recited in claim 23; and

said evaporator (111) is adapted to exchange heat with a heat radiation portion (104) of said Stirling refrigerating machine (101).